SUITABLE ECONOMIC POISONS

Speech delivered by JAMES C. MUNCH at conference Division of Predatory Animal and Rodent Control, Bureau of Biological Survey, Denver, Colorado, April 27 to May 2, 1931.

The subject assigned me is "Suitable, economic poisons," but to be perfectly frank in opening this discussion, I will have to confess I am like the farmer that went to the circus. He saw the calliope and thought it was wonderful. He saw the elephants, the monkeys, and the man who swallowed the sword -- that was quite beyond his understanding. But when he saw the giraffe, he felt as I do about a suitable economic poison -- "there isn't any such animal." The control measures of the Bureau have for their object, control. It might be worth while to consider for a moment the psychology behind this entire control project. I have read a great deal lately regarding the "balance of nature." As I conceive the work of this Division, and to some extent the work of the Bureau, it consists in a further directed attempt to upset an already disturbed balance of nature. The growth of civilization has very definitely caused a change in this so-called balance of nature; and our problem and aim in the control measures we are undertaking is to upset it further. We are doing this because we believe we have sufficient information and sufficient evidence to justify us in such an undertaking. Our critics do not believe we have sufficient information to justify us in such a project. As I see it that is the fundamental point of difference between us.

The psychology of the animals we desire to control is a new concept. We started out to control certain animals. We did not pay much attention to season, diet, or ecology. Our idea was to eliminate, or to decrease the available numbers of the animals that we were pursuing. We accomplished a great deal, but it was rather haphazard. Considered thought has led to the development of definite methods and policies for the further control of predatory animals or rodents. In that connection I think possibly our psychology could be quoted in terms of the Chicago gangster -- to "put the varmint on the spot, and give him the rap." In more refined language, first consider the necessity for the control of each rodent and predatory animal. Where we find the degree of damage is insignificant over a given area or zone, the control methods are not needed. Where control becomes necessary, we have three types of methods which can be employed; (1) Repellants, (2) Attractants, and (3) Exterminants or poisons. A repellant is a substance which interferes with the animals desire to go some place. We don't want him where he wants to go, so we expose a repellant to drive him off. We want to keep rabbits from gnawing on trees, so we place a repellant on the bark of the trees. If rats or mice are distributed through a large building and we wish to exercise a method of control, it is quite feasible to start at the top of the building with napthaline or something else the rat does not like; step by step move down into the basement where traps or poison may be used. A repellant is simply a substance that diverts the animal from the place he wants to go.

An Attractant is a substance that lures the animal where we want him to go, whether he wants to go or not. That is, the coyotes are running at large and we want them to go to a certain spot so we put out an attraction such as scent or station. It is much simpler to handle animals if we can bring them in to us than if we have to go out after them.

These two forms of control are admittedly of limited power, but as preliminary measures, are no doubt quite effective. Mr. Young has requested the writing of a leaflet in which information on attractants and repellants has been summarized. Except the work Mr. Silver has done already on this subject, I find that there is practically no other available information. Searches of Chemical Abstracts, Biological Abstracts, Biochemische Zeitschrift, Comptu Rendues de la Societe de Biologie, and other journals have failed to reveal any specific publications upon these subjects. I have learned more in talking with you men during the last two days than I have in the year spent in searches of literature. Accordingly, I am going to take the liberty of requesting each one of you to write out the practical information which you have upon attractants and repellants and send it to me or to Mr. Silver, that this information may be incorporated in this leaflet. We are constantly getting requests for this type of information, such as the value of castor bean plants in the control of the spread of moles.

It must be appreciated that our desire is to obtain a definite measure of control. Under certain circumstances it may be possible that we desire to exercise a limited control which can be effected by repellants or by attractants, and that definite extermination is not desirable. I readily admit that circumstances may often arise which require complete control, but would suggest that consideration be given to the use of repellants or attractants whenever feasible.

We are conceited enough to believe that we are more important than any other animals on this earth, and that we are fully justified to interfere with their rights and privileges to serve our own ends. Under no other conditions is it possible to conceive of the desirability of instituting control measures.

Various types of control measures have been suggested from time to time. It is not necessary to discuss traps in this connection. A poison is a substance which is capable of producing death. Poisons fall in all three categories; solid, liquid, and gas. Where gasses are used in control measures, they are designated as "fumigants." The most widely used fumigant is HCN (hydrocyanic acid). Without violating the confidential information obtained from contacts with the War Department, I may state that none of the war gasses developed during the recent World War have shown sufficient promise to justify their consideration as means of control. However, it is quite probable that interest directed toward the use of fumigants in control procedure will lead to the development of gasses showing definite benefit in our work.

Probably the oldest poison which has been employed for control measures is "arsenic" (arsenious oxide). As a matter of information, reading early Latin reports indicates that Mrs. Toffana introduced the use of arsenic as an insecticide. She established a sorority in Italy some three hundred years ago; the membership were discontented wives of the community. Believing that their obnoxious husbands were insects, they introduced the use of a solution of arsenic as an insecticide, solely for control purposes. This sorority has not entirely disappeared. About two years ago a chapter was found in Hungary; approximately 100 wives administered a preparation of arsenic to their husbands at about the same time. This sorority was broken up -- they hanged the women.

Arsenic has been studied with the possibility of developing a suitable rodent and predatory animal poison, but has not justified the original hopes. The patent application of Dr. Hedenberg of the Mellon Institute states that colloidal arsenic is very toxic to rats -- unfortunately, the rats have not read the patent specifications and often refuse to die. Organic arsenic compounds are quite expensive and do not offer hopes of becoming "economic" poisons. Inorganic arsenic compounds are not specific or selective and do not offer much hope of becoming "suitable" poisons.

In the early days of maritime warfare it was found that an enemy's wooden ship could be incapacitated by tossing several balls of Greek fire upon it. This practice was then applied to land warfare in control measures, with the development of the active ingredient - phosphorous - as a toxic agent. Yellow phosphorous exerts a specific attractant action upon rats, which is a point in its favor. This property is not found with many of its combinations. However, it is dangerous because of the possibility of starting fires in wheat fields or granaries. It is often employed where business is poor and insurance is high. In rodent control phosphorous has more drawbacks than good qualities. Phosphorous may be administered in solid or vapor phases. Under either condition, it is absorbed and carried to the liver where it produces a specific derangement of function, and death results from acute hepatic involvement. It almost inevitably leads to death, which is a horrible end with this poison. I have seen several men, and many animals dying from phosphorous poisoning, and do not wish to see another one. The first effect of phosphorous is exerted upon the stomach (gastritis, nausea, and vomiting) followed by an apparent remission of symptoms. After an interval of 6 to 10 days delayed poisoning becomes noticeable with involvement of the liver, which almost certainly leads to death. If possible, phosphorous should be completely replaced in control practice.

Death may result from failure of respiration or failure of circulation. Too minute a classification cannot be attempted. When the exhaust of a Ford is connected to a rat hole, (which appears to be a common newspaper report if not a general survey practice), carbon monoxide (CO) in the exhaust is responsible for death. In general, oxygen from the inhaled air is absorbed through the alveoli of the lungs into the blood stream where it combines with the hemaglobin. When this compound reaches the tissues, the oxygen is split off, and utilized by the cells. When CO combines with the hemaglobin, this directly deprives the tissues of oxygen and death results from asphyxia. When an animal is exposed to a fatal concentration of hydrocyanic acid (HCN), a similar death is produced through another mechanism. HCN combines with the tissues, impairing or destroying their ability to utilize the oxygen transported in the blood.

About 1923 Mr. Silver and I became very much interested in a product which had been recommended in Europe for the treatment of rodents -- red squill. Squill has an effect upon the heart similar to digitalis, and it was well known that the rat was very, very resistant to digitalis. Accordingly, I made the pharmacological prediction that red squill would not be worth using -- which prediction was fully justified by our subsequent findings that it was a completely satisfactory control poison. Red squill differs from white squill in that it contains red pigment dots. We found for the first time that in addition to constituent of red squill affecting the heart to which the rat is resistant,

there is also present another constituent which selectively paralyzes the respiratory center. The rat is about one hundred times as resistant as other animals to the heart action. Red squill powder is readily taken by rats (especially east of the Mississippi River) and by mice (in California and elsewhere). Rats do not vomit; they pay no attention to the bundles of calcium oxalate which act as deterrents and prevent consumption of red squill mixtures by pigeons, chickens, pigs, cats, dogs, children, and other predatory animals. Therefore, red squill is a desirable and a very specific poison. The details of preparation of red squill were reported in Tech. Bull. 134, and an abstract of that report has been given you this morning (Leaflet No. 65).

Bands of natives combed the forests of certain sections of South America and of Africa to collect members of the Strychnos family, which were brought home, cooked into soup with fish and other nauseous ingredients, and used to coat the points of their arrows or spears. One of the active constituents is Curare. If we could procure this material, it would be of material aid to our control procedure. Although it is not readily absorbable when given by mouth, it is easily taken from cuts or wounds. Passing into the blood stream, it is absorbed and exerts a selective action upon the myo-neural junctions (the specific spot where the nerve transmits an impulse to the muscle). However, this product is not available.

Another toxic substance originally present in this native stew and used by these natives in control methods, to control the number of men in the armies of their enemies, is strychnine. Strychnine has been employed as a rodent as well as a predatory animal poison since the beginning of the Survey's operative work. It is rather readily absorbed, regardless of the method of administration, and has the marked disadvantage of being quite toxic to all forms of life. It is readily absorbed into the blood stream and sensitizes the spinal cord, also destroys the "balance of nature" in neuro-muscular imbalance. This leads to the characteristic strychnine type of convulsions, which culminate in death from respiratory failure.

From the very beginning of the use of strychnine, more care has been given to <u>quantity</u> than to <u>quality</u> of use. In fact, we used to brag about the quantity of strychnine used rather than the degree of protection or the measure of control produced. I personally feel that as much care should be exercised in the placement of a single strychnine poison bait, as in the placement of a trap. The purpose is the same: the trap or the bait is expected to control an animal. Under these conditions, I believe that we could justifiably pay more attention to quality of distribution of strychnine, as well as of other poisons, and pay less attention to the quantity aspect.

I undertook an intensive investigation of the possibilities of rendering strychnine more selective in its action. Twelve mixtures of quinine and strychnine are officially recognized in N. F. V. and there are a number of private formulae which use this combination as a tonic. Drug manufacturers make elixor of iron, quinine and strychnine in tank car lots and tablets or pills by the millions. These official preparations contain from 10 parts to 50 parts of quinine for each part of strychnine. The dose of the mixture which is recommended contains about one-fourth of the usual tonic of strychnine.

Experiments upon about six thousand animals to date (gold fish, earthworms, mice, rats, guinea pigs, rabbits, cats, and dogs) have shown that the presence of quinine greatly increases the pharmacological activity of strychnine. A mixture containing a small quantity of quinine makes the strychnine from two to five times as potent as with strychnine alone, and tends to explain the empiric observations leading to the development of the various N. F. mixtures.

This highly interesting observation has been tested on a practical scale by Ward. The certain lethal dose of strychnine for dogs was considered to be 1.75 grains. When half of this quantity of strychnine was replaced by quinine, 24 of 30 dogs died somewhat earlier than with strychnine alone. Since quinine costs about half as much as strychnine this may have an economic bearing, if further work confirms the value of this mixture. There is another feature which entitles this to very serious consideration. Quinine is less resistant to weathering than strychnine. The distribution of a quinine-strychnine mixture would leave less total strychnine on a given area than the use of an equally toxic bait containing strychnine alone. This makes for greater specificity of action coupled with less danger of accidental poisoning of animals not subject to control.

In discussing the next poison, I am somewhat in the position of the high school senior who was a great lover of Patrick Henry and never missed an opportunity to introduce his name into any and all discussions. In desperation the debating society of which he was a member assigned him the topic "Colic in Horses", believing that for once they would be spared the agonies of Patrick Henry. Much to their surprise, when the fateful night for his speech came he arose with remarks somewhat along this line: "When I was assigned the topic of colic in horses I had no idea what it was. In an attempt to find out, I have read many books and magazine articles on this subject and have reached the conclusion that colic in horses is nothing more nor less than an accumulation of gas in the intestines of the horse, madly rushing back and forth, and exclaiming in the words of that immortal American patriot "Give me liberty or give me death!" I am now about to discuss thallium.

A German manufacturer offered a product called "Zelio" for entry into U. S. When Mr. Silver brought this to my attention in 1924, no information was available regarding its composition. Chemical analysis showed that it contained a very rare substance which had originally been discovered in the dust of a sulphuric acid plant by Crookes in 1861, and given a name "thallium" from the Greek "thallos" (a young shoot) on account of the green color of its flame spectrum. Feeding tests showed that Zelio killed rats and led us to attempt to procure some pure thallium sulphate for laboratory investigations. With difficulty, we were able to get 5 grams of material at a cost of about $5.00 as I remember it. Our laboratory work showed the great toxicity of this substance and its possibility for field use in rodent and predatory animal control.

It is not my purpose to discuss the field application of thallium at this time. However, I desire to call your specific attention to the concluding paragraph of Tech. Bull. 238 upon thallium, which has just been published.

"Thallium is a cumulative poison of high toxicity and is without taste, smell, or other warning property. It should not be recommended to the public as a rodent poison. Where the use of thallium is found necessary for the control of highly resistant species of rodents, it should be entrusted only to persons who understand its dangerous qualities and who will exercise appropriate care in handling it."

I believe that this caution for use in rodent control can be applied directly to predatory animal control. This bulletin outlines the pertinent information in the literature, and has 148 references to published work. It also contains our laboratory results. I do not feel that the caution regarding toxicity is overdrawn. Of course, I do not want to frighten you -- but the material is toxic. Handled under proper conditions, it is not apt to cause acute poisoning. However, it is known to be a cumulative poison just as lead is a cumulative poison. Small quantities may be stored in the system for a long period of time, then suddenly cause an impairment of function which is properly permanent. The specific action of thallium is exerted upon the autonomic nervous system; its depilatory action will remove all of the hair which becomes erect when you are frightened or mad. On the other hand, it will not interfere with your eyebrows or mustaches (if any). I will admit that we have not had deaths from thallium in the Survey. However, that is just our good fortune. Strychnine is a poison even though some members of the Survey fail to appreciate that fact in their usual methods of handling it. So far as I know, we have not had any deaths from strychnine among the Survey personnel. Nevertheless, I do not believe that we can over-emphasize the necessity for caution in handling these or any other poisons.

A study of any rodent or predatory animal poison necessitates a thorough investigation by the Laboratory from the standpoints of chemistry, toxicology, pharmacology, pathology, and pharmacy, before we are willing to place it in your hands for field use. We now know a number of substances which are poisonous: however, the information which we have at the present time does not justify any recommendation for any new poison for your use. Further laboratory studies are contemplated and any information will be brought to your attention as it becomes available. During the last ten years, squill and thallium have been developed into practical weapons for control. The results to be expected during the next ten years cannot be predicted, of course, but we feel certain that further help may be expected in the solution of a variety of your problems.

At the present time, about one half of the time of members of the Control Methods Research Laboratory is being efficiently expended upon operational work which could be as efficiently handled by members of the Bureau's forces. If we could be relieved of this operational work, we would have just twice as much time to spend on research work, which after all is the purpose of the Laboratory. We should be two or three years ahead of the operational force, so that when a problem arises, we can give you the benefit of our experience. As a matter of fact, we are five to ten years behind on a number of these problems. I realize that I am somewhat more able to stand off at a distance and view these from a different standpoint than the more active members of the Survey. I have no desire to intrude into the established methods for the operation of the Bureau, but simply desire to offer this for your consideration.

When I was in Montreal, Canada two weeks ago, attending a convention of the American Pharmacological Society, I was greatly impressed by the remarks of one of the speakers. He stated that he had asked a prominent speaker how long a speech should be, and had been informed to follow the example of wheelwright; "The longer the spoke, the greater the tire."